AMENDMENTS TO THE SPECIFICATION

Please replace the paragraph beginning at **page 1, line 5**, and insert the following rewritten paragraph:

The present invention relates to ~~a gait generating device and~~ a control device suited not only to walking but also to running of a legged mobile robot.

Please replace the paragraph beginning at **page 68, line 26**, and insert the following rewritten paragraph:

More specifically, the change ΔMr of a floor reaction force moment horizontal component per unit acceleration in the direction of each horizontal axis (X-axis, Y-axis) in the body inclination mode corresponds to the inertial moments of horizontal axis flywheels (FHx and ~~Fhy~~FHy).

Please replace the paragraph beginning at **page 97, line 26**, and insert the following rewritten paragraph:

If the coefficient of friction between the floor and the foot 22 is denoted by μ, and an effective radius of the surface of contact between the floor and the foot 22 to generate a moment vertical component (or a square root of a sectional secondary moment about a desired ZMP of the surface of contact between the floor and the foot 22) is denote by r, then Mzmin must be always set to be not less than $-\mu * r *$

floor reaction force vertical component, and Mzmax must be set to be not more than $\mu * r *$ floor reaction force vertical component. A simplest setting method is to set them according to the following expression, in which ka is a positive constant that is smaller than 1.

~~Mzxmin~~ Mzmin = -ka * μ * r * Floor reaction force vertical component

Mzmax = ka * μ * r * Floor reaction force vertical component

Please replace the paragraph beginning at **page 139, line 21**, and insert the following rewritten paragraph:

Then, the initial body posture angular velocities of Equations 37a and 37b and the heights of the trapezoids of ZMPrec (the trapezoidal patterns shown in Fig. 30) related to the integration of the second terms of the right sides of Equations 37a and 37b are taken as unknown numbers (However, the times of the break points of the trapezoidal patterns of ZMPrec are determined beforehand. Further, a trapezoidal height acyc1 of ZMPrec of a first turning gait and a trapezoidal height acyc2 of ZMPrec of a second turning gait are set to have the same value.) An initial body posture angular velocity determined by solving the simultaneous equation of Equations 37a and 37b including the unknown numbers is decided as a new initial body posture angular velocity. In this case, the terminal body posture angular velocity in Equation 37b is obtained by coordinate-converting the initial body posture angular velocity, which is an unknown number, into a value observed from a next time's gait supporting leg coordinate system by a matrix based on the above total

turning angle of a normal gait.

Please replace the paragraph beginning at **page 160, line 10**, and insert the following rewritten paragraph:

Then, the initial total center-of-gravity vertical position/velocity of the normal gait determined as described above are substituted into the terminal total center-of-gravity vertical positions/velocities of the following equations 41a and 41b, and the total center-of-gravity vertical position and velocity of the last time desired gait instantaneous value (to be more precise, the value obtained by converting the terminal state of the last time desired gait into the current time's gait supporting leg coordinate system) are substituted into the initial total center-of-gravity vertical positions and velocities of Equations 41a and 41b. Then, a floor reaction force vertical component pattern (to be more specific, a parameter value) of the current time gait is determined such that the relationship between Equations 41a and 41b is satisfied. The integrated values in Equations 41a and 41b are to be the integrated values in the period from the start to the end of the current time gait.

Please replace the paragraph beginning at **page 165, line 24**, and insert the following rewritten paragraph:

The explanation will now be given. In S800, various elements are initialized. Specifically, zero is substituted into time k for generating a provisional gait. Furthermore, the initial state of the current time gait is obtained by converting the

terminal state of the last time desired gait (to be more specific, the terminal values of the gait states, including a horizontal body position/velocity, a vertical body position/velocity, a body posture angle and its angular velocity, a desired foot position/posture, and a desired arm posture) into a current time's <u>gait </u>supporting leg coordinate system.

Please replace the paragraph beginning at **page 208, line 9**, and insert the following rewritten paragraph:

Further alternatively, a function that combines the aforesaid relationship, which has been mapped or processed into an approximate expression, and the aforesaid function f may be mapped or processed into an approximate expression and stored. More specifically, from the normal gait parameters composed of the aforesaid foot trajectory parameters, the floor reaction force vertical <u>component</u> trajectory parameters, etc., the functions for directly determining the divergent components of normal gaits may be mapped or processed into approximate expressions and the results may be stored. For example, a normal gait may be generated in advance for each set of a plurality of types of typical normal gait parameters, the initial state of the normal gait for each set of normal gait parameters (to be determined in S024 of Fig. 13) may be determined beforehand, and a map that shows the relationship between the normal gait parameters of each set and the normal gait initial states may be prepared in advance. Then, when generating a desired gait, the initial state of a normal gait may be determined by selecting or interpolating from among the sets of the determined normal gait parameters on the

basis of the aforesaid map. This arrangement obviates the need for generating a normal gait each time a current time gait is generated, thus permitting a significant reduction in the amount of calculation for the processing of generating a desired gait.

Please replace the paragraph beginning at **page 247, line 12**, and insert the following rewritten paragraph:

In this Fig. 60, the same processing as that from S010 to S028 of the main flowchart (Fig. 13) of the aforesaid first reference example is carried out from S2010 to S2028. In the initialization in S800 of the flowchart of Fig. 43, which is the subroutine of S028 (S2028 in the present embodiment), the initial state of a current time gait is obtained by converting the terminal state of the last time corrected gait (the final gait that the gait generating device 100 outputs) into a current time's <u>gait</u> supporting leg coordinate system. The terminal state of the original gait determined in S2032, which will be discussed hereinafter, is not used in S800 of the subroutine of S2028.

Please replace the paragraph beginning at **page 254, line 12**, and insert the following rewritten paragraph:

Subsequently, the processing proceeds to S2210 wherein, based on the difference in antiphase arm swing angle between models, a required value Mafdmd of the floor reaction force moment for stabilizing a model antiphase arm swing angle

that is necessary for converging the difference to zero is determined. If the floor reaction force moment for generating an antiphase arm swing angular acceleration of the antiphase arm swing mode of the corrected gait is merely matched with the floor reaction force moment for generating an antiphase arm swing angular acceleration of the antiphase arm swing mode of the original gait, then the difference in the antiphase arm swing angle between models does not converge to zero. The required value Mafdmd of the floor reaction force moment for stabilizing a model antiphase arm swing angle has a meaning as a moment resulting from subtracting the floor reaction force moment for generating the antiphase arm swing angular acceleration of the antiphase arm swing mode of the original gait from the floor reaction force moment generated when a motion is made to return the antiphase arm swing angle of the corrected gait to the antiphase arm swing angle of the original gait by an antiphase arm swing mode.

Please replace the paragraph beginning at **page 265, line 16**, and insert the following rewritten paragraph:

Subsequently, the processing proceeds to S2218 wherein a desired floor reaction force moment vertical component for compliance control is determined according to the equation shown in the figure. The floor reaction force moment vertical component that balances with the corrected gait in the equation shown in the figure (dynamically balances with the motion of the corrected gait) is the sum of a floor reaction force moment vertical component without correction and a model antiphase arm swing stabilization floor reaction force moment. Alternatively,

however, the floor reaction force moment vertical component about a desired ZMP may be directly calculated on the basis of a current time instantaneous value of the motion of a finally determined corrected gait.

Please replace the paragraph beginning at **page 272, line 21**, and insert the following rewritten paragraph:

As an alternative construction, the simplified model 100c1 may not be included in the full-model correction unit ~~100c2~~100c. The full model 100c2 includes either an inverse full model (an inverse dynamic full model) or a forward full model (a forward dynamic full model), as will be discussed hereinafter.

Please replace the paragraph beginning at **page 296, line 20**, and insert the following rewritten paragraph:

In other words, the antiphase arm swing angle correcting perturbation model 231 is represented by equation a23c. The perturbation model floor reaction force horizontal component for correcting antiphase arm swing angle ~~Fr~~ Fa is determined according to Equation a21c as described above (Fa = 0).

Please replace the paragraph beginning at **page 327, line 25**, and insert the following rewritten paragraph:

Meanwhile, the corrected desired floor reaction force moment vertical

component with restriction ~~Mltd~~ Mltdz is output as the desired floor reaction force moment vertical component for compliance control about a desired ZMP.

Please replace the paragraph beginning at **page 328, line 2**, and insert the following rewritten paragraph:

More specifically, according to the following Equation ~~h35~~h36, a corrected desired floor reaction force moment vertical component about the desired ZMP is determined as the final desired instantaneous value of the floor reaction force moment vertical component (the moment vertical component about the desired ZMP), these are output.

Please replace the paragraph beginning at **page 328, line 16**, and insert the following rewritten paragraph:

After the processing of the antiphase arm swing angle correcting perturbation model moment determiner 230 is carried out as described above, the antiphase arm swing angle correcting perturbation model moment Ma is supplied to the antiphase arm swing angle correcting model 231 shown in Fig. 66, and the correcting perturbation model antiphase arm swing angle θca that balances with the supplied antiphase arm swing angle correcting perturbation model moment Ma is calculated by using Equation a23c (by integrating).

Please replace the paragraph beginning at **page 347, line 1**, and insert the

following rewritten paragraph:

Further in the fifth reference example, an antiphase arm swing angle ~~moment~~ correcting perturbation model moment Ma is determined in the antiphase arm swing angle correcting perturbation model moment determiner 230.

Please replace the paragraph beginning at **page 347, line 22**, and insert the following rewritten paragraph:

Subsequently, in a calculator 230g, a corrected desired floor reaction force moment vertical component without restriction Minz is determined by subtracting the last time value (an output of an integrator, which will be discussed later) of the antiphase arm swing angle correcting perturbation model moment Ma from the sum of the full-model floor reaction force moment vertical component Mfullz, the compensating total floor reaction force moment vertical component Mdmdz, and the required value Mafdmd of antiphase arm swing angle correcting perturbation model stabilization moment. Then, in a restricting means (restriction processing unit) 230h, a restriction is added to the corrected desired floor reaction force moment vertical component without restriction Minz so that it does not exceed a floor reaction force vertical component moment permissible range (that is, passing it through a shown saturation characteristic function), thereby determining the corrected desired floor reaction force moment vertical component with restriction Mltdz. Next, the value obtained by subtracting the sum of the full-model floor reaction force moment vertical component Mfullz, the compensating total floor reaction force moment

vertical component Mdmdz, and the required value Mafdmd of antiphase arm swing angle correcting perturbation model stabilization moment from the corrected desired floor reaction force moment vertical component with restriction Mltdz is integrated by an integrator 230i using an integration gain Ka so as to determine the antiphase arm swing angle correcting perturbation model moment Ma, which is output. In addition, the corrected desired floor reaction force moment vertical component with restriction Mltdz is output as the desired floor reaction force moment vertical component for compliance control.

Please replace the paragraph beginning at **page 349, line 1**, and insert the following rewritten paragraph:

The antiphase arm swing angle correcting perturbation model moment Ma and the desired floor reaction force moment vertical component for compliance control are determined in the antiphase arm swing angle correcting perturbation model moment determiner 230 as described above.

Please replace the paragraph beginning at **page 349, line 6**, and insert the following rewritten paragraph:

The determined correcting perturbation model body position Xc, the correcting perturbation model body posture inclination angle θc, the correcting perturbation model antiphase arm swing angle θca, the horizontal body position correcting perturbation model stabilization moment Mpf, and the antiphase arm

swing angle correcting perturbation model moment Ma are used as the last time values in the next time control cycle (time t + Δt) as previously described.

Please replace the paragraph beginning at **page 351, line 11**, and insert the following rewritten paragraph:

A simplified model 200 in Fig. 74 not merely represents a dynamic model, but it also represents the processing from S3510 to S3532 of Fig. 65 described above, namely, the processing for calculating (determining) simplified model gait instantaneous values. Further, in the processing for calculating (determining) a current time gait instantaneous value (the gait instantaneous value of a simplified model) in S3532, as explained in the above fourth reference example, the instantaneous value of a gait is generated, setting the model manipulation floor reaction force moment horizontal component about a desired ZMP to zero, then a perturbational motion of a body inclination mode that generates a simplified gait body posture inclination angle correcting moment Mr (last time value), which corresponds to the body posture inclination angle correcting perturbation model moment Mr described in the ~~third embodiment~~fourth reference example, a perturbational motion of a body translational mode that generates a simplified model horizontal body position correcting moment Mp (last time value), which corresponds to the horizontal body position correcting perturbation model moment Mp described in the ~~third embodiment~~fourth reference example, and a perturbational motion of an antiphase arm swing mode that generates a simplified model antiphase arm swing angle correcting moment Ma (last time value), which corresponds to the antiphase

arm swing angle correcting perturbation model moment Ma described in the fourth reference example are added thereto. Thus, the instantaneous value of a gait output by the simplified model 200 is corrected.

Please replace the paragraph beginning at **page 387, line 18**, and insert the following rewritten paragraph:

Further, in the embodiment using the second reference example, to determine the instantaneous value of a current time gait in, for example, ~~S03032~~ S3032 of Fig. 56, the processing from S5116 to S5122 of Fig. 78 may be inserted between S3411 and S3412 of Fig. 57, which shows the subroutine thereof. Such an embodiment (the third embodiment) provides the embodiments of the third to the seventh inventions in the present invention. In this case, the floor reaction force horizontal component in the third embodiment corresponds to a restriction object amount, while the body posture inclination angle error and/or the body posture inclination angular velocity error corresponds to the error of the state amount of the robot 1 in the third and the fourth inventions. Further, the floor reaction force horizontal component permissible range [Fxmin, Fxmax] for gait generation in the third embodiment corresponds to the permissible range of the restriction object amount. The dynamic model shown in Fig. 12 corresponds to the dynamic models in the invention. The motional component and the floor reaction force component of the current time gait instantaneous values determined in S3034 of Fig. 56 correspond to the instantaneous value of a desired motion and the instantaneous value of a desired floor reaction force. In the third embodiment, the floor reaction

force moment vertical component compensation amount permissible range may be variably set according to a slippage occurrence determination result.